REMARKS

Reconsideration and allowance are respectfully requested in light of the following remarks.

The features of claim 13 have been integrated into claim 1 and claim 13 has been canceled, to place the claims in better form for consideration on appeal by reducing their number. These amendments were not presented earlier due to the unforeseeability of the rejections being made final in light of Applicant's prior rebuttal to these rejections.

Claims 1-6, 11-16, 18, and 20-23 stand rejected, under 35 USC §103(a), as being unpatentable over Tanaka et al. (US 6,377,596) in view of Tokunaga et al. (US 5,425,808) and Nakamura et al. (JP 01-234389A). Claim 17 appears to be rejected, under 35 USC §103(a), as being unpatentable over Tanaka in view of Tokunaga and Nakamura and further in view of Davis et al. (US 6,051,849). Applicant respectfully traverses these rejections.

Claim 1 now recites:

> *A method for forming a single crystalline film comprising:*
> *forming an amorphous film on a single crystalline substrate,*
> *forming an opening in the amorphous film and thereby exposing a part of a surface of the substrate through the opening, and*
> *directing an atomic beam, a molecular beam, or a chemical beam toward the substrate at an incident angle of not more than 40 degrees with respect to the substrate surface to selectively and epitaxially grow a*

single crystalline film on the exposed surface of the substrate that laterally overgrows the amorphous film.

The applied references fail to suggest the features recited in claim 1 of directing an atomic beam, a molecular beam, or a chemical beam toward a single crystalline substrate, having an amorphous film formed thereon, at an incident angle of not more than 40 degrees with respect to the substrate surface to epitaxially grow a single crystalline film on an exposed surface of the substrate, via an opening through the amorphous film, that laterally overgrows the amorphous film. Distinctions between these features and the teachings of the applied references are discussed individually in the topical sections set forth below.

I. Proposed Teaching of Selective Epitaxial Lateral Overgrowth

The Final Rejection proposes that Tokunaga discloses, in lines 14-29 of column 2, the epitaxial lateral overgrowth of a GaAs film on an amorphous SiO_2 or Si_3N_4 film (Office Action section 2, first sentence of fourth paragraph). Tokunaga does not disclose epitaxial lateral overgrowth of any kind.

Contrary to the Final Rejection's proposal, Tokunaga discloses only vertical epitaxial growth and expressly states that no epitaxial lateral overgrowth occurs on the amorphous film formed on a substrate. Specifically, Tokunaga discloses in Fig.

5E that a GaAs film 15 is formed only on a nucleation surface of the substrate formed by implantation of As ions and no GaAs film is formed on the non-nucleation surface, which is the SiO2 film surface (Tokunaga col. 5, lines 20-25).

In the portion of Tokunaga's specification cited in the Final Rejection, Tokunaga discloses that selective deposition methods are known in which a monocrystal substrate is covered partially with an amorphous thin film, and the same material as the substrate material is epitaxially grown selectively only at the exposed portion of the monocrystal substrate (col. 2, lines 13-18 (emphasis added)). For example, there is the selective epitaxial growth (SEG) method in which a silicon monocrystal substrate is partially covered with silicon oxide to effect selective growth of silicon (B. D. Joyce & J. A. Baldrey, Nature vol. 195,485, 1962), and the method in which a GaAs substrate is covered partially with an amorphous thin film, such as SiO_2, Si_3N_4, etc., to effect, selectively, epitaxial growth of GaAs (P. Rai-Choudhury & D. K. Schroder, J. Electrochem. Soc., 118, 107, 1971), etc. (col. 2, lines 18-27).

As may be determined by examination of the cited portion of Tokunaga's specification, Tokunaga expressly excludes the prospect of epitaxial lateral overgrowth occurring. Accordingly, the evidentiary record does not support the Final Rejection's

statement that Tokunaga discloses epitaxial lateral overgrowth of a GaAs film on an amorphous film.

Accordingly, Tokunaga does not suggest the claimed feature for which it is cited. Since the Final Rejection does not propose that any of the other applied references suggest the epitaxial lateral overgrowth of a single crystalline film on an amorphous film (by way of directing atomic, molecular, or chemical beams), it necessarily follows that the combined teachings of the applied references fail to suggest all of the claimed features. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted.

II. Proposed Suggestion of Equivalency between MBE and CVD

The Final Rejection proposes that Tokunaga suggests, in lines 30-35 of column 1, the equivalence of molecular beam epitaxy (MBE) and chemical vapor deposition (CVD) for the selective epitaxial lateral overgrowth of a single crystalline film on an amorphous film (Final Rejection page 2, last two lines, and page 3, lines 3-6). Tokunaga does not suggest the equivalency of MBE and CVD for any type of epitaxial growth, let alone for selective epitaxial lateral overgrowth.

Contrary to the Final Rejection's assertion, Tokunaga teaches, in the cited portion of his specification, that a

substrate 1 comprising a material species with uniform composition, as shown in Fig. 1A, is washed, and then a thin film 2 is deposited on the whole surface of the substrate 1, according to various thin film depositing methods (vacuum vapor deposition method, sputtering method, plasma discharging method, MBE method, CVD method, etc.) (Fig. 1B) (Tokunaga col. 1, lines 24-32). Subsequently, onto the thin film 2 there is applied a photoresist 3 (Fig. 1C), the photoresist 3 is exposed to light by use of a photomask of a desired pattern, and the photoresist 3 is removed partially by development (Fig. 1D) (col. 1, lines 32-38).

As may be determined by examination of the cited portion of Tokunaga's specification, Tokunaga does not suggest the equivalency of any two things in this portion. Although, Tokunaga discloses that a thin film may be deposited on the whole surface of a substrate according to various film depositing methods, including MBE, CVD, etc., Tokunaga does not suggest that any of these methods is equivalent to another for this purpose. More importantly, Tokunaga does not suggest that MBE is capable of producing epitaxial lateral overgrowth or that MBE produces equivalent results to CVD in the production of epitaxial lateral overgrowth. Furthermore, Tokunaga does not suggest that MBE is capable of selectively growing a single crystalline film on a single crystalline substrate through an opening in an amorphous

film formed on the substrate or that this manner of growth can produce epitaxial lateral overgrowth on the amorphous film.

Accordingly, the Final Rejection's conclusion that Tokunaga suggests the equivalency of CVD and MBE - for selectively growing a single crystalline film on a single crystalline substrate through an opening in an amorphous film formed on the substrate - is unsupported by the evidentiary record. Since the Final Rejection does not propose that any of the other applied references suggest this feature, it necessarily follows that the combined teachings of the applied references fail to suggest all of the claimed features. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted for this independent reason.

<u>III. Absence of a Suggestion to Apply Beam-Based Epitaxial Growth to Selective Epitaxial Lateral Overgrowth</u>

As mentioned in the preceding section, the applied references fail to suggest applying beam-based (i.e., atomic, molecular, or chemical beam) epitaxial growth to selective epitaxial lateral overgrowth. As recited in claim 1, beam-based epitaxy is employed for growing a single crystalline film on a single crystalline substrate through an opening in an amorphous film formed on the substrate.

Tokunaga and Nakamura fail to suggest anything concerning epitaxial lateral overgrowth. Although Tanaka may disclose producing epitaxial lateral overgrowth using continuous vapor deposition and Davis, which is not applied in the rejections of claim 1 or 13, may disclose such overgrowth using vapor phase epitaxy, neither reference discloses the potential to apply a beam-based form of epitaxial growth to producing epitaxial lateral overgrowth.

Accordingly, Applicant submits that the applied references do not suggest the subject matter defined by claim 1. Specifically, the applied references do not suggest a beam-based form of epitaxial growth for producing epitaxial lateral overgrowth, as recited in claim 1. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted for this independent reason.

IV. The Combination of Teachings That Support the Proposed Motivation to Combine the Applied References Does Not Suggest the Claimed Invention

The Final Rejection proposes that Nakamura discloses a molecular ray method of performing epitaxy wherein the angle of incidence between the substrate and the molecular beam can be optimized between zero and 90 degrees (Final Rejection page 3,

fourth paragraph). Continuing, the Office Action proposes that the motivation to combine the teachings of Nakamura with those of Tanaka and Tokunaga would be to optimize the epitaxially grown crystal by optimizing the molecular beam's angle of incidence with the substrate on which the crystal is grown (Final Rejection page 3, fifth paragraph).

Even assuming, *arguendo*, that the proposed motivation exists to combine the teachings of the applied references, the combination of teachings that support the proposed motivation does not suggest the subject matter of claim 1.

As discussed in the sections above, none of the applied references suggests applying beam-based epitaxial growth to the generation of epitaxial lateral overgrowth on an amorphous film. Since only vertical epitaxial growth is suggested by the combined teachings of the applied references, this must be the form of growth to which Nakamura's molecular beam is applied when operated in conjunction with the teachings of Tanaka and Tokunaga.

Recall from above that the proposed motivation for combining Nakamura's teachings with those of Tanaka and Tokunaga is to optimize the epitaxially grown crystal by optimizing the angle of incidence at which the beam strikes the substrate, upon which the crystal is grown. The only teaching provided by the applied

references for optimizing a vertically grown crystal, by way of varying the epitaxial growth beam's angle of incidence, is that provided by Nakamura. And this teaching indicates that the growth rate of the vertically epitaxially grown crystal is optimized by directing the molecular beam so that it strikes the substrate, upon which the crystal is grown, at a 90 degree angle. Moreover, Nakamura discloses that as the angle of incidence is monotonically lowered from 90 degrees toward an angle of zero degrees, the rate of crystal growth monotonically decreases from a maximum growth rate to a minimum growth rate.

Based on Nakamura's teachings, which are the only relevant teachings of record, a skilled artisan would set a beam's angle of incidence to 90 degrees to optimize a crystal's vertical growth rate. Since optimizing a crystal's vertical growth rate is the only aspect of the crystal that the references suggest may be affected by varying the beam's angle of incidence, it follows that the proposed motivation for combining the reference teachings would necessarily induce a skilled artisan to set the beam's angle of incidence at 90 degrees to achieve the proposed motivation of optimizing the grown crystal.

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation

to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art (MPEP §2143.01 third paragraph, first sentence). A skilled artisan's application of the teachings suggested by the proposed motivation would result in applying the epitaxial growth beam at a 90 degree angle of incidence with respect to the growth substrate, not an angle of 40 degrees or less as recited in claim 1. As is educed by the discussion above, the claimed method cannot be derived from and is not suggested by the reference teachings that would support the proposed motivation to combine these references.

Accordingly, Applicant submits that teachings supported by the proposed motivation do not suggest the claimed combination. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted for this independent reason.

V. The Combination of Teachings Suggested by the Proposed Motivation Teaches Away from Developing the Invention

Assuming again, *arguendo*, that the proposed motivation (as described in the preceding section) exists to combine the teachings of the applied references, the combination of teachings suggested by the proposed motivation necessarily teaches away from (i.e., discourages) developing the combination of features

defining the method of claim 1. This result must necessarily follow for the following reasons.

Recall from the preceding section that the proposed motivation for combining Nakamura's teachings with those of Tanaka and Tokunaga is to optimize the epitaxially grown crystal by optimizing the angle of incidence at which the beam strikes the substrate. The only teaching provided by the applied references for optimizing a vertically grown crystal, by way of varying the epitaxial growth beam's angle of incidence, is that provided by Nakamura. And this teaching indicates that the growth rate of the vertically epitaxially grown crystal is optimized by directing the molecular beam so that it strikes the substrate at a 90 degree angle. Moreover, Nakamura discloses that as the angle of incidence is monotonically lowered from 90 degrees toward an angle of zero degrees, the rate of crystal growth monotonically decreases from a maximum growth rate to a minimum growth rate.

Based on Nakamura's teachings, which are the only relevant teachings of record, a skilled artisan would be discouraged from lowering a beam's angle of incidence because it would reduce a crystal's vertical growth rate. Since optimizing the crystal's growth rate is the only motivation proposed for combining the references, a skilled artisan would not find motivation to lower

the beam's angle of incidence because lowering the angle of incidence is counterproductive to the proposed motivating influence.

A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path that was taken by the applicant (see *In re Gurley*, 27 F.3d 551, 553, 31 USPQ2d 1130, 1131 (Fed. Cir. 1994)). Such is the case here. A skilled artisan would be discouraged from following Applicant's path based upon the proposed motivation for combining the teachings of Nakamura with those of Tanaka and Tokunaga.

Accordingly, Applicant submits that the applied references teach away from the subject matter defined by claim 1. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted for this independent reason.

VI. Additional Remarks

To promote a better understanding of the difference between the claimed invention and the applied references, Applicant submits the following additional remarks.

Applicant submits that the CVD film-forming technique is quite different in principle from the MBE film-forming technique and the operation and apparatus of the CVD film-forming technique

are also quite different from those of the MBE film-forming technique. Tokunaga only teaches conventional film-forming techniques, such as CVD, MBE, sputtering, and vacuum deposition. However, these film forming techniques are quite different in principle and construction from one another.

For example, with the CVD technique, only gas sources are required, but with the MBE technique one or more beam sources are required in addition to the gas sources. As a result, the MBE apparatus structure is more complicated than the CVD apparatus structure. With the CVD technique, the raw material gases are non-directionally supplied onto a substrate, but with the MBE technique the molecular or atomic beam from the beam source is directionally supplied onto a substrate. Therefore, the operation of the MBE technique is more complicated than that of the CVD technique.

In addition, in sputtering, the gaseous ions are generated from a plasma (e.g., through the application of voltage to a sputtering gas that bombards and erodes a target to generate sputtered particles) and deposited onto a given substrate. In this case, in film forming, no raw material gas is employed and only sputtering gas is employed. In this point of view, sputtering is quite different in principle and construction from MBE and CVD. In this way, Tokunaga does not teach the

conventional film forming techniques in view of principle and construction.

In the use of the MBE technique for realizing epitaxial growth, conventionally, the molecular or atomic beam is supplied substantially perpendicularly onto the substrate because if the beam is supplied at a slant, for example, at a lower angle of not more than 40 degrees, the epitaxial growth can not be realized and some voids are created in the resultant film. The MBE characteristics are apparent from Figs. 1 and 2 of Nakamura. Referring to Figs. 1 and 2 of Nakamura, as the angle of incidence to the substrate decreases, the thickness of the deposited film decreases.

In the present invention, in contrast, even though a low angle of incidence is employed with the MBE technique, the film deposition can be realized because an amorphous film mask and an opening are employed. In addition, conventionally, the ELO technique, which Davis teaches, is only employed in CVD with non-directionality and not in MBE with directionality because in MBE the intended film can be formed without a mask due to the directionality. In contrast, the present invention is conceived on the fact that even in MBE a film-forming technique with low dislocation density can be realized by using the amorphous material mask and the lower incident angle, wherein the incident

beams are reflected on the inner side surfaces of the openings of the mask because the mask is made of the amorphous material.

Until the present invention was conceived, the above-mentioned fact was not suggested by the conventional techniques because in MBE it is believed that the beams are deposited on the inner sides of the openings of the mask and not on the substrate. In this point of view, the present invention was conceived against the conventional technical common knowledge.

Accordingly, Applicant submits that the applied references do not suggest the subject matter defined by claim 1. Therefore, allowance of claim 1 and all claims dependent therefrom is warranted for these independent reasons.

In view of the above, it is submitted that this application is in condition for allowance and a notice to that effect is respectfully solicited.

If any issues remain which may best be resolved through a telephone communication, the Examiner is requested to telephone the undersigned at the local Washington, D.C. telephone number listed below.

Respectfully submitted,

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